# IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re the Application of: **HAYASHI, Noriya**

Group Art Unit:**1712**

Serial No.: **09/664,332**

Examiner: **Robert E. Sellers**

Filed: **September 18, 2000**

P.T.O. Confirmation No.: 4422

For: **ENERGY RAY-CURING RESIN COMPOSITION**

## RESPONSE TO NOTIFICATION OF NON-COMPLIANT APPEAL BRIEF

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

November 13, 2006

Sir:

In response to the Office communication mailed November 8, 2006, submitted herewith is an Appeal Brief in the above-identified U.S. patent application. The Appeal Brief now contains the section "Related Proceedings Appendix" as required by 37 CFR 41.37(c)(1). The content of the Appeal Brief is otherwise unchanged from that filed on November 22, 2005.

In the event that any additional fees are due with respect to this paper, please charge Deposit Account No. 01-2340.

Respectfully submitted,

ARMSTRONG, KRATZ, QUINTOS,
HANSON & BROOKS, LLP

Daniel A. Geselowitz, Ph.D.
Agent for Applicant
Reg. No. 42,573

DAG/bh
Atty. Docket No. **001195**
Suite 1000
1725 K Street, N.W.
Washington, D.C. 20006
(202) 659-2930

23850
PATENT TRADEMARK OFFICE

Enclosure: Appeal Brief

THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Appeal No:

In re the Application of: **HAYASHI, Noriya**

Group Art Unit: **1712**

Serial No.: **09/664,332**

Examiner: **Robert E. Sellers**

Filed: **September 18, 2000**

P.T.O. Confirmation No.: 4422

For: **ENERGY RAY-CURING RESIN COMPOSITION**

**BRIEF ON APPEAL**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Date: November 13, 2006

Sir:

In accordance with 37 CFR §41.37, this Appeal Brief is filed subsequent to the Notice of Appeal filed on September 26, 2005.

# TABLE OF CONTENTS

## I. REAL PARTY IN INTEREST

The real party in interest is Mitsubishi Heavy Industries, Ltd., of Tokyo, Japan, as evidenced by the assignment recorded on September 18, 2000, on Reel 011133, Frame 0143.

## II. RELATED APPEALS AND INTERFERENCES

Applicant is aware of no related prior or pending appeals, interferences or judicial proceedings which are related to, directly affect, or will be directly affected by the Board's decision in this appeal.

## III. STATUS OF CLAIMS

The status of the claims in this application is as follows:

Rejected: Claims 1-3, 6-8, 10, 12, 22, 27 and 28

Canceled: 4, 5, 9, 11, 13-21, 23-26

Allowed: None

Withdrawn: None

All of the rejected claims, 1-3, 6-8, 10, 12, 22, 27 and 28, are under appeal.

## IV. STATUS OF AMENDMENTS

An amendment after final rejection was made on September 26, 2005. This amendment only canceled withdrawn claims 9, 17-19, 21 and 23-26. In the Advisory action dated October 3, 2005, the Examiner indicated that the amendment would be entered upon filing of the appeal brief. The Status of Claims (section III) and Claims Appendix (section VIII) reflect entry of this amendment.

## V. SUMMARY OF THE CLAIMED SUBJECT MATTER

There are three independent claims involved in the appeal: claims 1, 27 and 28.

Claim 1

Claim 1 is directed to an "energy-ray curing resin composition", that is, a composition that can be cured by an energy ray such as ultraviolet light, an electron beam, infrared light, visible light, etc. (page 1, lines 1-11 of the specification). The composition comprises:

a) a "photopolymerizable resin component which can be cured by irradiation with an energy ray". This can be a photopolymerizable oligomer or a photopolymerizable monomer (page 7, line 6). Examplary photopolymerizable resin components are listed on page 26, lines 4-18.

b) "a photopolymerization initiator component", which is further limited in claim 1 to comprising a sulfonium salt of formula (IV), (IV') or (V) (page 10, line 23, to page 11, line 24). This function of the photopolymerization initiator component is stated as "which makes it possible to cure by chain reaction said photopolymerizable resin component with irradiation of an energy ray" (see page 23, lines 14-16).

c) a "curing agent component capable of curing at least one of said photopolymerizable resin components without irradiation of an energy ray." Support for this recitation may be found in the specification, for example, on page 6, lines 14-16. This property is further discussed on page 29, lines 2-17, in particular in lines 9-14. Claim 1 recites that the curing agent "comprises an acid anhydride or a derivative thereof". Support for this recitation may be found on page 8, lines 3-7, in which it is explained that the "derivative" may be a dicarboxylic acid or an esterified product thereof. Exemplary acid anhydrides are given in the specification in Table 6 on page 41.

In the second-to-last clause of claim 1, there is a limitation on the proportion (i.e., ratio) of the curing agent component to the photopolymerizable resin component: 0.3 to 1.4 mol of curing agent component per 1 mol of photopolymerizable resin component. This is disclosed in the specification on page 35, lines 1-8. In particular, the upper limit of 1.4 is disclosed on page 45, line 3, and the lower limit of 0.3 is disclosed on page 45, line 7.

In the last clause of claim 1, there is a limitation on the proportion of the photopolymerization initiator to the other components than the photopolymerization initiator: 0.1 to 6.0 parts photopolymerization initiator per 100 parts of the whole weight of the other components. This is disclosed in the specification on page 49, lines 15-18.

<u>Claim 27.</u>

Claim 27 is directed to "a composition for an energy-ray curing resin-molded article". As disclosed on page 16, lines 15-21, an energy-ray curing resin-molded article includes a resin-cured matter and a resin product obtained by curing the energy-ray curing resin composition.

As in claim 1, the composition comprises:

a) a "photopolymerizable resin component which can be cured by irradiation with an energy ray". This can be a photopolymerizable oligomer or a photopolymerizable monomer (page 7, line 6). Examplary photopolymerizable resin components are listed on page 26, lines 4-18.

b) "a photopolymerization initiator component", which is further limited to comprising a sulfonium salt of formula (IV), (IV') or (V) (page 10, line 23, to page 11, line 24). This function of the photopolymerization initiator component is stated as "which makes it possible to cure by chain

reaction said photopolymerizable resin component with irradiation of an energy ray" (see page 23, lines 14-16).

c) a "curing agent component capable of curing at least one of said photopolymerizable resin components without irradiation of an energy ray." Support for this recitation may be found in the specification, for example, on page 6, lines 14-16. This property is further discussed on page 29, lines 2-17, in particular in lines 9-14. The claim recites that the curing agent "comprises an acid anhydride or a derivative thereof". Support for this recitation may be found on page 8, lines 3-7, in which it is explained that the "derivative" may be a dicarboxylic acid or an esterified product thereof. Exemplary acid anhydrides are given in the specification in Table 6 on page 41.

In the second-to-last clause of the claim, there is a limitation on the proportion (i.e., ratio) of the curing agent component to the photopolymerizable resin component: 0.3 to 1.4 mol of curing agent component per 1 mol of photopolymerizable resin component. This is disclosed in the specification on page 35, lines 1-8. In particular, the upper limit of 1.4 is disclosed on page 45, line 3, and the lower limit of 0.3 is disclosed on page 45, line 7.

In the last clause of the claim, there is a limitation on the proportion of the photopolymerization initiator to the other components than the photopolymerization initiator: 0.1 to 6.0 parts photopolymerization initiator per 100 parts of the whole weight of the other components. This is disclosed in the specification on page 49, lines 15-18.

Claim 28.

Claim 28 recites "An energy-ray curing composition for a paste material". Paste materials include magnetic paste, conductive paste, solder, metal paste, inorganic paste and rib paste (for thin display panels), as disclosed on page 16, line 22, to page 17, line 2.

As in claim 1, the composition comprises:

a) a "photopolymerizable resin component which can be cured by irradiation with an energy ray". This can be a photopolymerizable oligomer or a photopolymerizable monomer (page 7, line 6). Examplary photopolymerizable resin components are listed on page 26, lines 4-18.

b) "a photopolymerization initiator component", which is further limited to comprising a sulfonium salt of formula (IV), (IV') or (V) (page 10, line 23, to page 11, line 24). This function of the photopolymerization initiator component is stated as "which makes it possible to cure by chain reaction said photopolymerizable resin component with irradiation of an energy ray" (see page 23, lines 14-16).

c) a "curing agent component capable of curing at least one of said photopolymerizable resin components without irradiation of an energy ray." Support for this recitation may be found in the specification, for example, on page 6, lines 14-16. This property is further discussed on page 29, lines 2-17, in particular in lines 9-14. The claim recites that the curing agent "comprises an acid anhydride or a derivative thereof". Support for this recitation may be found on page 8, lines 3-7, in which it is explained that the "derivative" may be a dicarboxylic acid or an esterified product thereof. Exemplary acid anhydrides are given in the specification in Table 6 on page 41.

In the second-to-last clause of the claim, there is a limitation on the proportion (i.e., ratio) of the curing agent component to the photopolymerizable resin component: 0.3 to 1.4 mol of curing

agent component per 1 mol of photopolymerizable resin component. This is disclosed in the specification on page 35, lines 1-8. In particular, the upper limit of 1.4 is disclosed on page 45, line 3, and the lower limit of 0.3 is disclosed on page 45, line 7.

In the last clause of the claim, there is a limitation on the proportion of the photopolymerization initiator to the other components than the photopolymerization initiator: 0.1 to 6.0 parts photopolymerization initiator per 100 parts of the whole weight of the other components. This is disclosed in the specification on page 49, lines 15-18.

## VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

There is **one** ground of rejection:

**Claims 1-3, 6-8, 10, 12, 22, 27 and 28 are rejected under 35 U.S.C. §103(a) as being unpatentable over Hamazu et al. (US Patent No. 5,359,017); Buchwalter et al. (US Patent No. 5,879,859; Starkey (US Patent No. 5,384,339) and Green (US Patent No. 4,252,592) in view of Green (US Patent No. 4,299,938).** (Office action of July 7, 2005, pages 2-4)

## VII. ARGUMENT

Applicant here presents arguments against the one ground of rejection:

**Claims 1-3, 6-8, 10, 12, 22, 27 and 28 are rejected under 35 U.S.C. §103(a) as being unpatentable over Hamazu et al. (US Patent No. 5,359,017); Buchwalter et al. (US Patent No. 5,879,859; Starkey (US Patent No. 5,384,339) and Green (US Patent No. 4,252,592) in view of Green (US Patent No. 4,299,938).** (As stated in the final Office action of July 7, 2005).

Claim grouping: claims 1-3, 6-8, 10, 12, 27, 28: Claims 1-3, 6-8, 10, 12, 27, 28, of which claims 1, 27 and 28 are independent claims, are grouped together for purposes of this appeal.

The arguments here can be considered with reference generally to claim 1. Applicant notes that the recitation of independent claim 1 is the same as that of independent claims 27 and 28, except for the limitations in the first lines of the claims, i.e., "an energy-ray curing composition" in claim 1, "a composition for an energy-ray curing resin-molded article" in claim 27, and "an energy-ray curing article for a paste material" in claim 28.

Summary of the rejection as stated by the Examiner.

The final office action of July 7, 2005, states that the rejection is maintained for reasons of record set forth in the previous Office actions (page 2, 4th paragraph). The Office actions of January 31, 2005, May 28, 2004, January 15, 2004, also refer back to previous Office actions, and the rejection was originally stated on page 2 of the Office action of **July 24, 2003**.

The Examiner cites Hamazu et al. and Green '592 as disclosing a combination of photopolymerizable initiator and an anhydride curing agent, noting that the limitation of 0.3 to 1.4 mole curing agent per mol of photopolymerizable resin is not disclosed in these references.

The Examiner then cites Buchwalter et al. in column 8, Example 1, as disclosing a blend of 1.8 parts by weight of acetal diepoxide (i.e., acetaldehyde bis(3,4-epoxycyclohexylmethyl)acetal) according to column 3, lines 13-15), 0.91 parts by weight of hexahydrophthalic anhydride and a photoinitiator such as the disclosed sulfonium salt (column 3, line 22). The Examiner calculates that "the molar quantity of anhydride is 0.91÷154.17 = 0.0059 mole, and that the molar amount of diepoxide is 1.8 ÷283 = 0.0064 mole, and that the molar ratio of curing agent per mole of photopolymerizable resin is therefore 0.93.

The Examiner then states that:

> "Starkey espouses as much as 10 parts by weight (col. 21, lines 12-19) of a thermohardening catalyst such as the elected species of maleic anhydride per 100 parts by weight of an epoxy resin such as the elected species of 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate exhibited in Examples 2 (cols. 21-22) and 5 (col. 23) along with an aromatic sulfonium salt. The molar quantity of the cycloaliphatic diepoxide is 100 ÷ 316 - 0.316 mole. The molar ratio of curing agent per mole of photopolymerization resin is 0.10 ÷ 0.316 = 0.32:1 which is within the claimed parameters."

The Examiner states that it would have been obvious to employ the anhydride curing agent of Hamazu et al. and Green '592 within the molar ratios of Starkey and Buchwalter et al. of from 0.32:1 to 0.93:1 in order to complete the curing of the epoxy resin and to attain sufficient strength without crystal precipitation or decreased stability.

Organization of Applicant's Arguments:

In arguing against the rejection of all of the claims under appeal, Applicant makes two main arguments: a) no *prima facie* case of obviousness can be made for the claims based on the cited combination of references; and b) Applicant has provided evidence of unexpected results of the

present invention over the cited references, which would overcome the rejection even if there were a *prima facie* case of obviousness. Applicant argues these two lines of reasoning below under headings A and B.

**A. No *prima facie* case of obviousness can be made for the claims based on the cited combination of references**

1. Regarding the limitation on proportion of curing agent to photopolymerizable resin

Applicant submits that there are several errors in the Examiner's proposed *prima facie* case related to the Examiner's finding of a suggestion in the references for the recited claim limitation that the curing agent component is present at a proportion of 0.3 to 1.4 mol per mol of the photopolymerizable resin component. Again, this limitation is recited in claims 1, 27 and 28.

The present claims require a curing agent component that comprises an acid anhydride or a derivative thereof, and that this curing agent is present at a proportion of 0.3 to 1.4 mol per mol of the photopolymerizable resin component. In the rejection as stated on July 24, 2003, the Examiner notes that the Hamazu et al., Green '592 and Buchwalter et al. references disclose the use of anhydride curing agents. The Examiner acknowledges that the Hamazu et al. and Green '592 references do not disclose the "0.3 to 1.4" proportion limitation at issue. Buchwalter is discussed primarily with regard to the limitation of the last clause of claim 1. In order to find a suggestion for the curing agent limitation of the second-to-last clause, the Examiner turns to Starkey.

The Examiner's original arguments with regard to the general teaching of Starkey may be found in the Office action of July 24, 2003, on page 3, 2nd paragraph, and the Examiner's most

recent arguments may be found in the final Office action of July 7, 2005, on pages 2 and 3 (points 1-3).

The Examiner's arguments for the suggestion of the "0.3 to 1.4" proportion limitation in Starkey are based in part on Starkey's general teaching, and mainly on Starkey's Examples. To a certain extent, these arguments are intermingled, and Applicant here argues that **Starkey's general disclosure does not provide a suggestion for the claimed proportion of curing agent component to photopolymerizable resin component.**

Starkey generally relates to epoxy resin compositions, in photocurable compositions in which "The epoxy resin and polyol is combined with a photoinitator" (column 11, line 40). Starkey states in column 20, line 10, that: "Thermohardening catalysts **may** be used" (emphasis added). These are therefore **optional** components. The reference describes thermohardening catalysts in column 20, line 10, through column 21, line 23. The list of possible thermohardening catalysts is very long, but does include a general disclosure of acid anhydrides, with several examples in column 20, lines 34 to 49.

Again, the key issue at hand is the recitation in the claims of the limitation on the proportion of the curing agent component, which is an anhydride or a derivative thereof, to the photopolymerizable resin component, this proportion being 0.3 to 1.4 mol per mol.

The only general disclosure in Starkey relevant to this proportion appears to be in column 21, lines 12-23:

> "One of these thermohardening catalysts or a mixture thereof may be used preferably in an amount of from about 0.01 to 10 parts by weight, more preferably from about 0.05 to 5 parts by weight, based on 100 parts by weight of the resin component of the liquid light-sensitive resin composition. When the amount of the same is less than about 0.01 part by weight, the resulting film shows an insufficient

> strength. When it exceeds about 10 parts by weight, on the other hand, the resulting liquid light-sensitive resin composition suffers from some problems such as precipitation of crystals or a decrease in the stability of the liquid."

That is, Starkey discloses that the ratio of thermohardening catalyst to resin component, by weight is (0.01 to 10):100, or more preferably (0.05 to 5):100. The ratio is **not discussed in molar terms**. Moreover, as noted above, the disclosure of thermohardening catalysts in Starkey is extremely broad, and would cover an enormous range in molecular weights. This is similarly true of the possible thermohardening catalyst components.

That is, Starkey does not indicate that the molar ratio is significant, and Starkey's general weight proportion of these components would encompass an enormous, essentially **undefined**, range of molar proportions.

In order to find a suggestion in Starkey for a molar proportion within the claimed proportion, the Examiner selects **specific examples** of the thermohardening catalyst and resin component, and selects a **specific value** within Starkey's range of weight proportions. As noted above, the Examiner states:

> "Starkey espouses as much as 10 parts by weight (col. 21, lines 12-19) of a thermohardening catalyst **such as the elected species of maleic anhydride** per 100 parts by weight of an epoxy resin such as the elected species of 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate exhibited **in Examples 2 (cols. 21-22) and 5 (col. 23)** along with an aromatic sulfonium salt." (emphasis added)

That is, the Examiner is attempting to derive a suggestion for the recited proportion of curing agent (comprising acid anhydride or derivative thereof) to resin from Starkey's examples 2 and 5, as may be seen in the Examiner's arguments on page 3, 2nd paragraph, of the Office action of July 24, 2003, repeated on page 2 of the Office action of July 7, 2005.

Specifically, the Examiner chooses the examples of maleic anhydride as the thermohardening catalyst (curing agent) and 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate as the resin component; and chooses the value of 10 parts thermohardening catalyst to 100 parts resin, this being the upper limit of Starkey's range. With these examples, the Examiner finds that the proportion of curing agent to resin component would be 0.32, falling barely within the range of 0.3 to 1.4 in the present claims.

However, Applicants notes the following points about the Examiner's choices:

a) As may be seen from the Examiner's arguments (Office action of July 7, 2005, page 2, last paragraph), the Examiner's selection of 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate is based on Starkey's Example 5 (column 23, lines 12-26). However, Starkey's Example 5 does **not** use maleic anhydride. In fact, Starkey's example 5 **does not use any thermohardening catalyst,** but only a photoinitator. To summarize, the Examiner is attempting to derive a limitation for a specific ratio of anhydride thermohardening catalyst to resin from an example that **does not even have any thermohardening catalyst**.

In Starkey's Example 2, again, there is a photoinitiator and sensitizer, but there is **no thermohardening catalyst**. Again, Applicant argues that no suggestion regarding the proportion of the thermohardening catalyst can be obtained from an example not having a thermohardening catalyst.

b) The Examiner's calculation is based entirely on a hypothetical weight ratio of 10 parts by weight thermohardening catalyst to resin (see, for example, final Office action of July 7, 2005, page 2, bottom paragraph (paragraph no. 1)). This ratio comes from the extreme upper limit of the range

in Starkey, column 21, lines 23. That this is the extreme upper limit may be seen from Starkey's comment that:

> "When it exceeds about 10 parts by weight, on the other hand, the resulting liquid light-sensitive resin suffers from some problems such as precipitation of crystals or a decrease in the stability of the liquid." (column 21, lines 19-23)

However, selection of this upper limit is essential to the Examiner's argument, since if any lower value than 10 parts were selected with the chosen examples of maleic anhydride and 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate, the Examiner's calculated proportion (0.32) would fall below 0.3 and out of the claimed range.

Applicant notes that the Examiner also refers to Example 2 in this calculation. However, Example 2 of Starkey uses a mixture of 50 parts cycloaliphatic resin to 20 parts hexadecane resin. This would have a different average molecular weight than 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane, and the Examiner's calculated proportion value of 0.32 is clearly incorrect if this is the resin. Applicant is uncertain of the molecular weight of the hexadecane resin, but Applicant suspects that the Examiner's calculation performed with this mixture as the resin will not fall within the claimed range.

Moreover, the Examiner's selection of low molecular weight maleic anhydride (being one of the lightest possible anhydrides, or indeed, thermohardening catalyst) is also essential to the Examiner's argument. If the molecular weight of the anhydride were much greater, the Examiner's calculated proportion (0.32) would fall below 0.3 and out of the claimed range. Applicant also notes the Examiner's reference to the choice of the "elected species of maleic anhydride". This "election" refers to Applicant's election in response to a restriction requirement, and is in no way related to the teachings of Starkey.

Similarly, the Examiner's selection of the relatively high molecular weight 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate helps the Examiner's calculation fall within the recited range.

Summary:

In the Examiner's *prima facie* case, the suggestion for the claim limitation that the "curing agent component is present with a proportion of 0.3 to 1.4 mol per mol of said photopolymerizable resin component" is based entirely on the disclosure of Starkey. Starkey clearly does not directly teach this limitation, and the "thermohardening catalyst" (i.e., curing agent) is an optional component in Starkey. In order to obtain this limitation from the reference, the Examiner picks and chooses: 1) an **upper limit** (10:100) of the amount of the possible ratio of thermohardening catalyst to resin by weight, as taught by the reference ; 2) a specific anhydride (maleic anhydride) thermohardening catalyst from Starkey's extremely long list of possible catalysts, most of which are not anhydrides; 3) a resin used in one Example (Example 5) of the reference, that Example **not using any thermohardening catalyst**. The thermohardening catalyst (maleic anhydride) is chosen for its low molecular weight, which allows this combination of components and the selected ratio value to barely fall within the range recited in the present claims. Applicant submits that this is an **improper picking and choosing** of optional components and ranges in the reference to find a possible combination that falls within the range of the present claims.

Finally, Applicant notes that the arguments by the Examiner fail to address the combination of limitations of the last two clauses of claim 1, that is, the ratio of curing agent to

photopolymerizable resin **and** the ratio of photopolymerizable resin component to the other components, both of which must be satisfied.

2) Regarding the limitation on photopolymerizable initiator component to other components

Applicant submits that there are errors in the Examiner's proposed *prima facie* case related to the Examiner's finding of a suggestion in the references for the recited claim limitation that the photopolymerizable initiator component is present at a proportion of 0.1 to 6.0 parts by weight per 100 parts of the other components. Again, this limitation is recited in claims 1, 27 and 28.

In paragraphs no. 7-8 of the Office action of January 31, 2005, the Examiner reviewed the disclosure of Buchwalter et al., analyzing Example 1 in column 9 of the reference. In Example 1, acetal diepoxide (1.8 parts), hexahydrophthalic anhydride (0.91 parts), UVI-6974 photoinitiator (0.54 parts), stannous octanoate (0.03 parts) and ethylene glycol (0.02 parts) were blended then cured at 130 °C, and later were exposed to light through a mask to create a positive image. The exact composition of UVI-6974 is not given, but the Examiner cites column 3, line 22, which indicates that the photoinitiator in general can be a sulfonium salt. Applicant believes that UVI-6974 contains "sulphonium, (thiodi-4,1-phenylene)bis[diphenyl-, bis[hexafluoroantimonate(l-)]]." "Acetal diepoxide" appears to refer to acetaldehyde bis-(3,4-epoxycyclohexylmethyl) acetal (column 3, lines 13-15).

In Example 1 of Buchwalter, the proportion of photopolymerization initiator to the other components is 0.54:2.76, which would be 19.6:100. The Examiner calculated the molar ratio of the the hexahydrophthalic anhydride to the resin as being 0.93:1, within the range in claim 1.

However, Applicant has responded that the photopolymerization initiator in Buchwalter's Example 1 is **well above the range of 1.0 to 6.0 parts by weight per 100 in claim 1**, Buchwalter clearly does not provide this limitation of claim 1. Therefore, the fact that, in Buchwalter's Example, the anhydride is within the molar proportion range of the second-to-last clause of claim 1 is irrelevant since the limitation of the last clause of claim 1 is not satisfied. The claims require that both limitations be met.

In the final Office action dated July 7, 2005, the Examiner now acknowledges that Example 1 does not provide the limitation of the last clause of claim 1, but states: "However, the teachings of a reference are not confined to the examples. Column 7, lines 1-3, sets forth from 0.5 - 10% by weight of the photoinitator which embraces the claim parameters" (page 3 at bottom).

In response, Applicant submits that the Examiner is focusing on a single limitation, when the **combination of two limitations** (last two clauses of claim 1) is at issue. Buchwalter's Example 1, cited in the Office actions, clearly meets only one of the limitations, and therefore **teaches away** from the claimed combination.

**B. Applicant has presented evidence of "unexpected results" for the claimed combination**

As discussed above, the present claims require the combination of several specific limitations, in particular, a limitation on the chemical structure of the photoinitiator, the requirement that the curing agent be an anhydride, and the limitations recited in the last two clauses of claim 1 (and claims 27 and 28): the proportion of curing agent to photopolymerizable resin must be 0.3 to

1.4 mol per mol; and the proportion of photopolymerizable initiator component must be 0.1 to 6.0 part per 100 parts other components.

Applicant has argued, based on the present specification and in three Declarations under 37 CFR 1.132 by Noriya Hayashi, that this combination of limitations provides a specific result that is unexpected based on the cited references. (The first declaration, executed on February 28, 2003, was filed on March 3, 2003; the second, executed May 12, 2004, was filed on May 13, 2004. The third, executed December 20, 2004, was filed on December 27, 2004). This result is what the Applicant calls "curing by chain reaction". In particular, Applicant presented experimental data in the 1.132 Declaration demonstrating that when this combination of limitations is met, that the resin, after an initial exposure to light, will continue to cure after the light is turned off ("after provision of energy is stopped"). Applicant has also offered to show the Examiner a video demonstrating this effect (see Response of December 27, 2004, page 3, second-to-last paragraph), but this demonstration has not yet been conducted. This effect of chain curing leads to a rise in temperature in the middle (2 cm deep) and lower (4 cm deep) parts of the resin, depths at which the light does not reach after curing starts.

In the Declaration filed on May 13, 2004, several examples were compared. The Declaration first notes Comparative Examples 2 and 3 of pages 75-76 of the present specification, which have a sulfonium salt (photoiniator component) within the limitations of the present claims, but no acid anhydride. In these cases, the "curing by chain reaction" effect is not observed, and the resin cures only on its surface where exposed to light. (This Declaration also refers to data in the Declaration filed on March 3, 2003, of Added Comparative Examples 1 and 2, in which the sulfonium salt used

was outside the limitations of the present claims, in which chain curing is not observed, even when an anhydride is present).

Finally, in the Declaration filed on December 27, 2004, four test examples are studied, differing in their content of maleic anhydride. The examples above or below the claimed 0.3 to 1.4 proportion did not show any curing at 4-cm depth, while the example at the proportion of 0.65, within the claimed range, did.

Applicant submits that the data presented in the specification and the Declarations adequately demonstrate that the "chain curing" phenomenon, which allows for curing after the light is turned off, and which allows for curing at depths of 4 cm, is observed when the claim limitations are met, but is not observed at typical reaction conditions such as those found in the prior art.

Applicant emphasizes that there is no disclosure of this phenomenon in any of the cited references. Moreover, there is no disclosure in any of the cited references of **any** criticality of any combination of the limitations of the present claims.

For example, as discussed above, the only suggestion provided by the Examiner for the limitation of the "0.3 to 1.4" proportion of anhydride curing agent to resin component is derived from Starkey. Yet in Starkey, the presence of a curing agent (thermohardening catalyst) is optional, anhydrides are only one of a long list of possible thermohardening catalysts, and the Examiner can derive a value within the range of 0.3 to 1.4 only by taking a hypothetical case of maleic anhydride, the resin from an Example with no thermohardening catalyst, and a weight ratio that is the upper limit taught by Starkey.

In the final Office action of July 7, 2005, the Examiner states that:

> "The evidence revealed in the declaration [filed December 27, 2004]only addresses the issue of the molar ratio of anhydride:photopolymerizable resin. However, the testing of a single molar ratio of 0.65:1 does not confer criticality throughout the claimed limits ranging broadly over an order of magnitude from 0.3:1 to 1.4:1. This test does not pertain to Buchwalter et al., which shows a molar ratio of 0.93:1 and whose issue is the concentration of photoiniator, not the molar ratio."

In response, Applicant argues that although the Declaration did not provide data over the entire claimed range, the data are sufficient to show a **criticality** of the ratio of anhydride to resin when the other limitations of the claim are met, where clearly there is no suggestion in Starkey (or any of the cited references) for any criticality associated with this ratio.

Moreover, with regard to the Examiner's comments regarding Buchwalter et al., the Examiner again refers to an Example of Buchwalter et al. in which the last clause of claim 1, the proportion of photoiniator to other components, was not met. The data in the Declaration are specifically directed to examples meeting the other claim limitations. Buchwalter's cited Example clearly cannot be suggesting the criticality of the claimed combination of limitations since it fails to meet one of the limitations, and Applicant submits that there is no suggestion in Buchwalter for any criticality associated with the claimed combination of limitations.

To summarize, Applicant submits that the evidence present in the Declarations under 37 CFR 1.132 make it clear that this **combination** of limitations is critical–that is, there is a **synergy** of these limitations. There is no suggestion in the cited references that such any such synergy exists. Applicant therefore argues that Applicant has adequately demonstrated an "unexpected effect" of the claimed invention over the cited references.

Applicant therefore argues that the claims under appeal are not obvious over Hamazu et al. (US Patent No. 5,359,017); Buchwalter et al. (US Patent No. 5,879,859; Starkey (US Patent No. 5,384,339) and Green (US Patent No. 4,252,592) in view of Green (US Patent No. 4,299,938), taken separately or in combination.

In the event this paper is not timely filed, appellant hereby petitions for an appropriate extension of time. The fee for any such extension may be charged to our Deposit Account No. 01-2340, along with any other additional fees which may be required with respect to this paper.

Respectfully submitted,

ARMSTRONG, KRATZ, QUINTOS,
HANSON & BROOKS, LLP

Daniel A. Geselowitz, Ph.D.
Agent for Applicant
Reg. No. 42,573

DAG/nrp:bh
Atty. Docket No. **001195**
Suite 1000
1725 K Street, N.W.
Washington, D.C. 20006
(202) 659-2930

23850
PATENT TRADEMARK OFFICE

Q:\FLOATERS\BRENDA\00 Cases\001195_Appeal Brief resubmitted 11-13-06

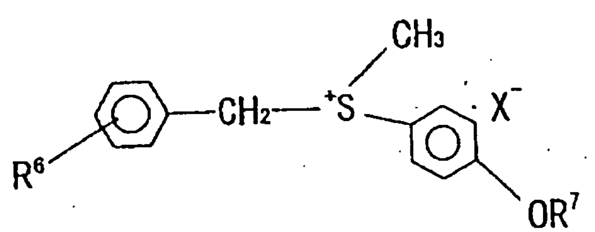
## VIII. CLAIMS APPENDIX

Claims 1-3, 6-8, 10, 12, 22, 27 and 28 are involved in the appeal:

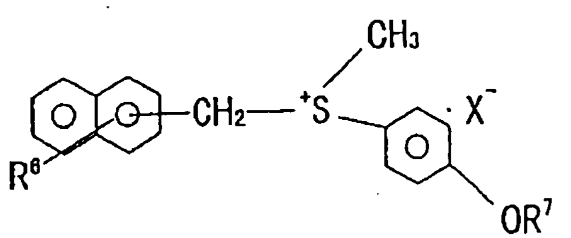
Claim 1 (Previously Presented): An energy-ray curing resin composition comprising a photopolymerizable resin component which can be cured by irradiation with an energy ray, a photopolymerization initiator component which makes it possible to cure by chain reaction said photopolymerizable resin component with irradiation of an energy ray, and a curing agent component capable of curing at least one of said photopolymerizable resin components without irradiation of an energy ray,

wherein said curing agent component comprises an acid anhydride or a derivative thereof,

said photopolymerization initiator component comprises a sulfonium salt, the sulfonium salt being a photo-thermopolymerization initiator which can initiate polymerization by both of light and heat, and being represented by the following general formula (IV), (IV'), or (V):

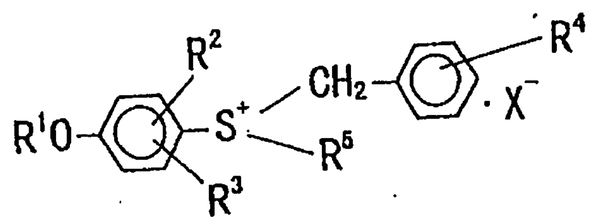


(IV)



(IV')

in Formula (IV) or (IV') described above, $R^6$ represents hydrogen, halogen, a nitro group or a methyl group; $R^7$ represent hydrogen, $CH_3CO$, or $CH_3OCO$; and $X^-$ represents $SbF_6^-$, $PF_6^-$, $AsF_6^-$ or $BF_4^-$;



(V)

in Formula (V) described above, $R^1$ represents hydrogen, a methyl group, an acetyl group, or a methoxycarbonyl group; $R^2$ and $R^3$ each independently represent hydrogen, halogen or an alkyl group of $C_1$ to $C_4$; $R^4$ represents hydrogen, halogen or a methoxy group; $R^5$ represents an alkyl group of $C_1$ to $C_4$; and x represents $SbF_6^-$, $PF_6^-$, $AsF_6^-$ or $BF_4^-$, and

wherein said curing agent component is present with a proportion of 0.3 to 1.4 mol per mol of said photopolymerizable resin component which can react with said curing agent component,

wherein said photopolymerization initiator component is present with a proportion of 0.1 to 6.0 parts by weight per 100 parts by weight of the whole weight of the other components than the photopolymerization initiator component.

Claim 2 (Original): The energy-ray curing resin composition as described in claim 1, further comprising a curing accelerator component which accelerates curing when curing at least one of said photopolymerizable resin components and said curing agent component without irradiation of an energy ray.

Claim 3 (Previously Presented): The energy-ray curing resin composition as described in claim 2, comprising an epoxy resin component having a cyclic ether structure in a molecular structure as the photopolymerizable resin component.

Claims 4-5 (Canceled)

Claim 6 (Previously Presented): The energy-ray curing resin composition as described in claim 2, comprising a monohydric or polyhydric alcohol as the curing accelerator component.

Claim 7 (Previously Presented): The energy-ray curing resin composition as described in claim 3, wherein said curing accelerator component comprises a compound which can react with the epoxy resin component and which does not have a nitrogen atom in a molecular structure.

Claim 8 (Previously Presented): The energy-ray curing resin composition as described in claim 3, comprising 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexanecarboxylate as the photopolymerizable resin component.

Claim 9 (Canceled)

Claim 10 (Previously Presented): The energy-ray curing resin composition as described in claim 6, comprising polyethylene glycol as the alcohols.

Claim 11 (Canceled).

Claim 12 (Previously Presented): The energy-ray curing resin composition as described in claim 2, wherein the curing accelerator component is present with a proportion of 0.04 to 0.6 mol per mol of the curing agent composition.

Claims 13-21 (Canceled)

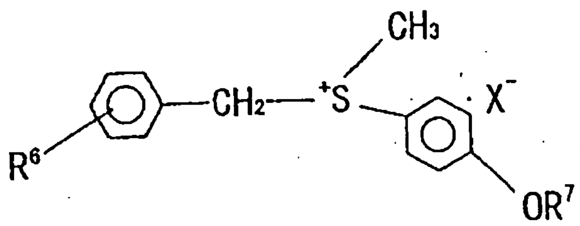
Claim 22 (Previously Presented): A paste material comprising the energy-ray curing resin composition as described in claim 1.

Claims 23-26 (Canceled)

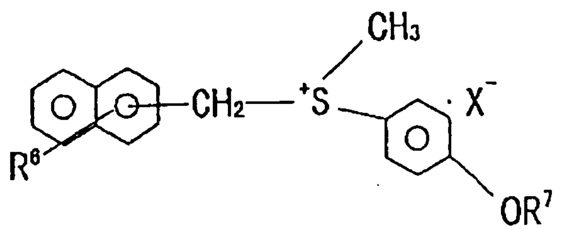
Claim 27 (Previously Presented): A composition for an energy-ray curing resin-molded article comprising a photopolymerizable resin component which can be cured by irradiation with an energy ray, a photopolymerization initiator component which makes it possible to cure said photopolymerizable resin component with irradiation of an energy ray, and a curing agent component capable of curing at least one of said photopolymerizable resin components without irradiation of an energy ray,

wherein said curing agent component comprises an acid anhydride or a derivative thereof, said photopolymerization initiator component comprises a sulfonium salt, the sulfonium salt being

a photo-thermopolymerization initiator which can initiate polymerization by both of light and heat, and being represented by the following general formula (IV), (IV'), or (V):

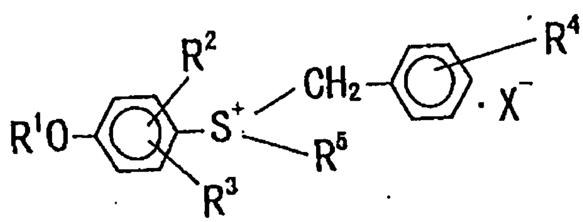


(IV)



(IV')

in Formula (IV) or (IV') described above, $R^6$ represents hydrogen, halogen, a nitro group or a methyl group; $R^7$ represents hydrogen, $CH_3CO$, or $CH_3OCO$; and $X^-$ represents $SbF_6^-$, $PF_6^-$, $AsF_6^-$ or $BF_4^-$;



(V)

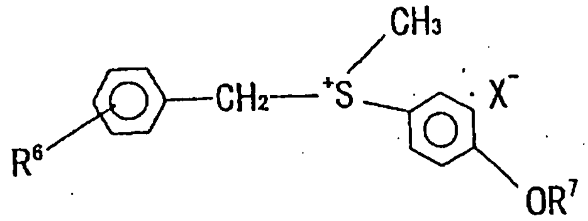
in Formula (V) described above, $R^1$ represents hydrogen, a methyl group, an acetyl group, or a methoxycarbonyl group; $R^2$ and $R^3$ each independently represent hydrogen, halogen or an alkyl group of $C_1$ to $C_4$; $R^4$ represents hydrogen, halogen or a methoxy group; R represents an alkyl group of $C_1$ to $C_4$; and x represents $SbF_6^-$, $PF_6^-$, $AsF_6^-$ or $BF_4^-$;

wherein said curing agent component is present with a proportion of 0.3 to 1.4 mol per mol of said photopolymerizable resin component which can react with said curing agent component,

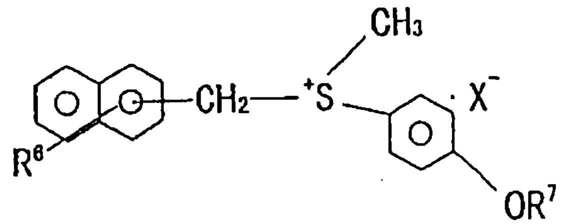
wherein said photopolymerization initiator component is present with a proportion of 0.1 to 6.0 parts by weight per 100 parts by weight of the whole weight of the other components than the photopolymerization initiator component.

28. (Previously Presented): An energy-ray curing resin composition for a paste material comprising a photopolymerizable resin component which can be cured by irradiation with an energy ray, a photopolymerization initiator component which makes it possible to cure said photopolymerizable resin component with irradiation of an energy ray, and a curing agent component capable of curing at least one of said photopolymerizable resin components without irradiation of an energy ray,

wherein said curing agent component comprises an acid anhydride or a derivative thereof, said photopolymerization initiator component comprises a sulfonium salt, the sulfonium salt being a photo-thermopolymerization initiator which can initiate polymerization by both of light and heat, and being represented by the following general formula (IV), (IV'), or (V):

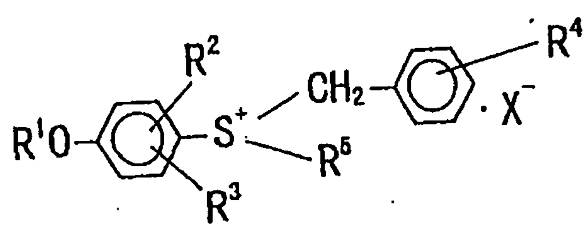


(IV)



(IV′)

in Formula (IV) or (IV') described above, $R^6$ represents hydrogen, halogen, a nitro group or a methyl group; $R^7$ represents hydrogen, $CH_3CO$, or $CH_3OCO$; and $X^-$ represents $SbF_6^-$, $PF_6^-$, $AsF_6^-$ or $BF_4^-$;



(V)

in Formula (V) described above, $R^1$ represents hydrogen, a methyl group, an acetyl group, or a methoxycarbonyl group; $R^2$ and $R^3$ each independently represent hydrogen, halogen or an alkyl group of $C_1$ to $C_4$; $R^4$ represents hydrogen, halogen or a methoxy group; $R^5$ represents an alkyl group of $C_1$ to $C_4$; and x represents $SbF_6^-$, $PF_6^-$, $AsF_6^-$ or $BF_4^-$;

wherein said curing agent component is present with a proportion of 0.3 to 1.4 mol per mol of said photopolymerizable resin component which can react with said curing agent component,

wherein said photopolymerization initiator component is present with a proportion of 0.1 to 6.0 parts by weight per 100 parts by weight of the whole weight of the other components than the photopolymerization initiator component.

## IX. EVIDENCE APPENDIX

Attached are copies of three Declarations under 37 CFR §1.132 filed during the prosecution of this application.

(1) Declaration by Noriya Hayashi, executed on February 28, 2003, and filed on March 3, 2003.

(2) Declaration by Noriya Hayashi, executed on May 12, 2004, and filed on May 13, 2004.

(3) Declaration by Noriya Hayashi, executed on December 20, 2004, and filed on December 27, 2004.

These Declarations were entered in the subsequent Office actions of April 16, 2003, May 28, 2004, and January 31, 2005, respectively.

## X. RELATED PROCEEDINGS APPENDIX

None.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of: **HAYASHI, Noriya**

Group Art Unit: **1712**

Serial No.: **09/664,332**

Examiner: **Robert E. Sellers**

Filed: **September 18, 2000**

**P.T.O. Confirmation No.: 4422**

For. **ENERGY RAY-CURING RESIN COMPOSITION**

**DECLARATION UNDER 37 CFR 1.132**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
Sir:

I, Noriya Hayashi, of c/o Nagoya Research & Development Center, MITSUBISHI HEAVY INDUSTRIES, LTD., 1, AzaTakamichi, Iwatsuka-cho, Nakamura-ku, Nagoya, Aichi-ken, Japan, hereby declare and state that:

1) I am the inventor of the above-referenced application.
2) I have read the final Office action dated May 28, 2004.
3) I have personally conducted or supervised the following experiments.

Test I (Added Example I)

Maleic anhydride 0.65 mol was added to one mol of Celoxide 2021P (alicyclic epoxy resin; 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane-carboxylate, manufactured by Daniel Chemical Co., Ltd.) and dissolved by stirring to obtain solution (a).

Blended with 100 parts by weight of solution (a) was 3.0 parts by weight of Sun Aid SI-100L (cationic photo-thermopolymerization initiator; Formula (IV), manufactured by Sanshin Chemical Co., Ltd., 50wt% solvent of ‿-butyrolactone), to yield solution (b).

A glass vessel (Ø 40 mm x H 50 mm) was charged with (b) so that the liquid height was 40 mm. This was irradiated with UV for 2 minutes. The irradiation conditions were a UV irradiation apparatus: UVL-1500M2 (manufactured by Ushio Denki Co., Ltd.); lamp type: metal halide lamp;

lamp intensity: 120 w/cm; lamp length: 125 mm; in air; at room temperature; under atmospheric pressure; and irradiation distance: 15 cm.

Result: The sample described above was completely cured in several minutes while chain curing.

Test II (Added Example II)

The same test as in Added Example 1 was carried out, except no maleic anhydride was added to Celoxide 2021P. (That is, only Celoxide 2021P was used in the solution corresponding to solution (a) in Added Example I.)

Result: The sample after 2 minutes UV irradiation was cured only 1 mm from the surface thereof, and the sample further after 1 hour at room temperature was also cured only 1 mm from the surface thereof, and the remainder was still liquid.

Test III (Added Example III)

The same test as in Added Example 1 was carried out, except that 0.01 mol of maleic anhydride was added in place of the 0.65 mol of maleic anhydride in solution (a) of Added Example I.

Result: The sample after 2 minutes UV irradiation was cured only 1 mm from the surface thereof, and the sample further after 1 hour at room temperature was also cured only 1 mm from the surface thereof, and the remainder was still liquid.

Test VI (Added Example VI)

The same test as in Added Example 1 was carried out, except that 2.5 mol of maleic anhydride was added in place of the 0.65 mol of maleic anhydride in solution (a) of Added Example I.

Result: The sample after 2 minutes UV irradiation was cured only 1 mm from the surface

thereof, and the sample further after 1 hour at room temperature was also cured only 1 mm from the surface thereof, and the remainder was still liquid.

Table of Test Results

| | Test Ⅱ | Test Ⅲ | Test Ⅰ | Test Ⅵ |
|---|---|---|---|---|
| 2021P | 1 mol | 1 mol | 1 mol | 1 mol |
| Maleic anhydride | C | 0.01 mol | 0. 65 mol | 2 . 5 mol |
| SI-100L | 3 wt. parts | 3 wt. parts | 3 wt. parts | 3 wt. parts |
| Thickness of cured layer | About 0.1 cm (The reminder is not cured. ) | About 0 . 1 cm (The reminder is not cured. ) | 4 cm | About 0.1 cm (The reminder is not cured.) |
| Determination of Curing at 4cm depth | X | X | O | X |

The undersigned declares that all statements made herein of his/her own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under ' 1001 of Title 18 of the United States Code and that willful false statements may jeopardize the validity of the application or any patent issued thereon.

Noriya Hayashi

Signature

Noriya Hayashi

Signed this 20 day of December, 2004

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of: HAYASHI, Noriya

Group Art Unit: 1712

Serial No.: 09/664,332

Examiner: Robert E. Sellers

Filed : September 18, 2000

P.T.O Confirmation No.: 4422

For : ENERGY RAY-CURING RESIN COMPOSITION

DECLARATION UNDER 37 CFR 1.132

Commissioner for Patents
Washington, D.C. 20231

Sir:

I, NORIYA HAYASHI, of c/o Nagoya Research & Development Center, MITSUBISHI HEAVY INDUSTRIES, Ltd., 1-Takamichi Iwatsuka-cho, Nakamura-ku, Nagoya-shi, Aichi-ken, Japan, declare and state ;

1. I am the inventor of the above identified application.

2. I am familiar with the Office Action dated September 3, 2002, and the prior art cited therein.

3. I and/or those under my direct supervision and control have conducted tests as follows:

Experiment data

Added Example 1

Maleic anhydride 0.65 mol was added to one mol of Celoxide 2021 P (alicyclic epoxy resin; 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane -carboxylate, manufactured by Daniel Chemical Co., Ltd.) and dissolved by

stirring to obtain a solution. - (a)

50wt% of Sun Aid SI-80L (cationic photo-thermopolymerization initiator; Formula (IV), manufactured by Sanshin Chemical Co., Ltd.) was made by using γ -butyrolactone as a solvent. - (b)

Blended with 100 parts by weight of (a) was 1.0 parts by weight of (b). - (c)

A glass vessel (Ø 30 mm(inside diameter 27.5 mm) x H 45mm) was charged with (c) so that the liquid height becomes 40 mm. This was irradiated with UV for 3 minutes. The irradiation conditions were a UV irradiation apparatus: UVL-1500M2 (manufactured by Ushio Denki Co., Ltd.), the kind of a lamp: metal halide lamp, a lamp intensity: 120 w/cm, a lamp length: 125 mm, in the air, at room temperature, under atomospheric pressure and an irradiation distance: 15 cm.

The sample described above was completely cured in several minutes while chain curing.

## Added Example 2

The same test as in Added Example 1 was carried out, except that Sun Aid SI-60 (cationic photo-thermopolymerization initiator; Formula (IV), manufactured by Sanshin Chemical Co., Ltd.) was blended in place of Sun Aid SI-80L.

The sample described above was completely cured in several minutes while chain curing.

## Added Example 3

Prepared was a mixture of CYRACURE UVI-6974 (cationic photo-thermopolymerization initiator (sulfonium salt), manufactured by Union Carbide Co.) and (b) in the Added Example 1 with a ratio of 8:2. - (d)

The same test as in Added Example 1 was carried out, except that (d) was blended in place of (b).

Added Comparative Example 1

The same test as in Added Example 1 was carried out, except that DAICAT 11 (aryl base sulfonium salt type/solvent = 1/1, manufactured by Danicel Chemical Co., Ltd.) was blended in place of (b).

The sample described above was cured only 2 mm from the surface thereof, and the remainder was still liquid.

Added Comparative Example 2

The same test as in Added Example 1 was carried out, except that CYRACURE UVI-6974 (cationic photo-thermopolymerization initiator (sulfonium salt), manufactured by Union Carbide Co.) was blended in place of (b).

The sample described above was cured 18 mm from the surface thereof, but the remainder was still liquid.

The undersigned declares that all statements made herein of his own knowledge are true and that all statements made on information and believed are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that willful false statements may jeopardize the validity of the application or any patent issued thereon.

Signed this 28 day of February, 2003

NORIYA HAYASHI

NORIYA HAYASHI

# IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

**HAYASHI, Noriya**

Serial No.: **09/664,332** Group Art Unit: **1712**

Filed: **September 18, 2000** Examiner: **Robert E.Sellers**

For: **ENERGY RAY-CURING RESIN COMPOSITION**

**DECLARATION UNDER 37 CFR § 1.132**

Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, NORIYA HAYASHI, of c/o Nagoya Research & Development Center, MITSUBISHI HEAVY INDUSTRIES, LTD., 1-Takamichi, Iwatsuka-cho, Nakamura-kyu, Nagoya-shi, Aichi-ken, Japan, declare and state;

1) That I am the inventor of the instant invention, and

2) That the experiments given below were carried out under my general direction and supervision.

I, the undersigned, declare that all statements made herein of my own knowledge are true and that all statements made of information and belief are believed to be true; and further that these statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

## Introduction

The currently pending claims recite a composition comprising a photopolymerizable resin component and a component which is "a photopolymerization initiator component which makes it possible to cure **by chain reaction** said photopolymerizable resin". The photopolymerization initiator component is specified by the structural formula (IV), (IV'), or (V). The curing mechanism by a specific photopolymerization initiator component of the present invention **by chain reaction** (i.e., **chain curing**) is distinguished from conventional photo curing and heat curing. The most remarkable difference of the chain curing from photo and heat curing is that, once the chain curing begins, curing proceeds being continuously propagated by the heat generated from its own chain curing reaction heat, even after provision of energy is stopped, whereas photo curing and heat curing require continuous energy provision to complete the curing. Therefore, in the present invention, **resin can be cured at a depth where no light reaches.**

This chain curing itself is found to be a new phenomenon that is different from conventionally known concepts of chain reaction by radical, and has never been known in the field of photo and heat curing. By utilizing this specific phenomenon, the present inventors have found the composition of the present invention by optimizing each of the composition components which have been selected and experimented based on a completely new basis. Accordingly, **the composition of the present invention is completely different** from conventional photo and heat curing in that the composition of the present invention is a composition to cure continuously.

## Experimental

Applicants here present the results of experiments demonstrating the difference between **chain curing** of the present invention and conventional photo curing.

Attached Figure A shows the change in temperature during chain curing of the resin composition of the present invention. The change in temperature of the resin component only is also shown as a comparison (Refer to "ref" in the Figure). In the experiment, a UV irradiation apparatus, UVL-1500M2 which has also been used in Example 2, was used and the irradiation distance was 17 cm. The vertical line shows a temperature of each depth (upper, middle and lower) and the horizontal line shows the irradiation time. As can be seen in Figure A, the resin composition of the present invention generated heat even at a lower depth during chain curing, while the temperature of the resin component (only) did not rise even when the same resin as used in the present invention was used. From the results of Figure A, it can be concluded that the specific phenomenon of curing by chain reaction (i.e., chain curing) will occur for the specific resin composition.

**Analysis and further comments**

As noted above, the photopolymerization initiator component included in the resin composition of the present invention refers to (is limited to) "a component which makes it possible to cure by chain reaction" which is specified by the structural formula (IV), (IV') or (V).

None of References cited by the Examiner discloses the component "which makes it possible to cure by chain reaction" or suggests the technical idea of curing resin by chain reaction. Further, the References do not disclose the use of the compound represented by the structural formula (IV), (IV') or (V) at all.

In contrast, the present invention is achieved based on the technical idea of curing resin by chain reaction. The present inventors have found that the compound represented by the formula (IV), (IV') or (V) is a component that makes it possible to cure by chain reaction. Thus, in the present invention, the compound represented by the formula (IV), (IV') or (V) is used as a photopolymerization initiator component. In addition, the amount ratio of the compound should be

within an adequate range. In other words, it is important that the compound is included in the ratio of 0.1 - 6.0 wt% in the resin composition in order to cure by chain reaction.

Further, in the composition comprising only the specific sulfonium salt of the formula (IV), (IV') or (V), chain curing does not occur. In order to generate chain curing, co-existence of both the specific sulfonium salt and an acid anhydride is necessary. Thus, the composition of the present invention includes both the compound specified by the formula (IV), (IV'), or (V) which is not disclosed in the References and an acid anhydride. The function of curing resin by chain reaction can be performed by the co-existence of the compound specified by the formula (IV), (IV') or (V) and an acid anhydride. The amount ratio of the acid anhydride is determined by the mechanism of curing resin by chain reaction and is thus in the range of 0.3 - 1.4 mol with respect to 1 mol of the resin component. If the amount of the acid anhydride is too small, curing does not proceed sufficiently. On the other hand, if the amount is too large, the resin component required for curing becomes less and the curing characteristics thus deteriorate.

In a system wherein an acid anhydride is added to a general sulfonium salt other than the specific sulfonium salt of the formula (IV), (IV') or (V), chain curing does not occur. This fact was shown in the test results (of Added Comparative Example 1 and 2) of the Declaration submitted to the U.S. Patent and Trademark Office on March 3, 2003. In addition, in a system in which an acid anhydride is added to the photopolymerization initiator described in U.S. Patent Nos. 5,879,859, 5,384,339, or the like, chain reaction does not occur.

The following is an explanation based on experimental examples to show that the composition specified in the present invention meets the specific requirements to perform chain curing.

In Comparative Examples 2 and 3 of the present invention, described on pages 75-76 of the specification, a composition with an acid anhydride having been removed was examined. That is,

a composition was prepared in which the specific sulfonium salt was mixed with a resin component and an acid anhydride was removed. The sample did not cause chain curing and was cured only on its surface, wherein the reminder was not cured. Thus, adding an acid anhydride to a resin is indispensable as a precondition to perform chain curing, and the preferable amount of the acid anhydride is in the range of 0.3 - 1.4 mole with respect to 1 mol of the resin component.

In Added Comparative Examples 1 and 2 submitted with the Declaration on March 3, 2003, a composition using a general sulfonium salt other than the specific sulfonium salt of the formula (IV), (IV'), or (V) was examined. In Added Comparative Example 1, a composition was prepared in which an aryl sulfonium salt type polymerization initiator was blended with a resin in which an acid anhydride was added. The sample did not cause chain curing and was cured only on its surface, wherein the remainder was not cured. In Added Comparative Example 2, a composition was prepared in which a cation sulfonium salt type polymerization initiator was blended with a resin in which an acid anhydride was added. The sample also did not cause chain curing and was cured only on its surface, wherein the remainder was not cured.

In contrast, the composition of the present invention includes a compound having a specific structural formula represented by a general formula (IV). The composition in a glass vessel (Ø40 mm x H50 mm) in which a specified amount of the compound of the general formula (IV) and an acid anhydride (maleic anhydride) were blended with a resin was completely cured by chain curing in a few minutes.

From the above results, in a system wherein an acid anhydride is added to a sulfonium salt other than the specific sulfonium salt of the structural formula (IV), (IV') or (V), chain curing does not occur even if a cation sulfonium salt type polymerization initiator described in the References was used. Thus, even if the References that do not disclose the component "which makes it possible to cure by chain reaction" specified by the formula (IV), (IV') or (V) were combined, their

combination could not have reached the present invention, i.e., energy-ray curing resin composition by chain curing. In addition, the skilled person could not have prepared the composition of the present invention by combining other structural component in anticipation of chain reaction, since the References do not suggest chain curing at all.

The functional effect to achieve chain curing of the present invention is completely different from that of the References and the effect is extremely remarkable.

In the conventional energy-ray curing shown in the References, although curing of a resin component itself proceeds by a photopolymerization initiator, curing does not proceed at a depth where no light reaches or where no light exists. Further, even if the features of the References are combined, complete curing cannot be performed at a depth where no light reaches in just a few minutes unless chain curing is achieved. In addition, in heat curing, since a heating device and a heating step (for a certain amount of time) are additionally required, curing in a short time with a simplified device as used in energy-ray curing is impossible.

Noriya Hayashi

Noriya HAYASHI

Signed this 12 day of May, 2004

Fig. A

# Temperature changes of resin